Enhanced Electrocatalytic Activity of Graphene-Gold Nanoparticles as a Superoxide Anion Biosensor Based on Immobilized Hemin

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doi: 10.20964/2018.09.12

Received: 4 April 2018 / Accepted: 25 May 2018 / Published: 5 August 2018

Inspired by the high electrocatalytic activity of electrochemically reduced graphene oxide-Au nanoparticles (ERGO-AuNPs) nanohybrid and their strong adsorption capacity for immobilizing biomolecules, we developed an ultrasensitive superoxide anion ($O_2^{\bullet-}$) electrochemical biosensor based on hemin immobilized on ERGO-AuNPs nanohybrid modified glass carbon electrode (GCE). The electrochemical properties of immobilized hemin were investigated. A considerably higher surface concentration (Γ^*) of the immobilized hemin was measured on the order of $1.02 \times 10^{-7} \text{ mol cm}^{-2}$. The results indicated that the ERGO-AuNPs nanohybrid enhanced the electrocatalytic activity of hemin for $O_2^{\bullet-}$ detection due to the synergy generated by ERGO and AuNPs. The resulting biosensor exhibited an excellent amperometric response toward $O_2^{\bullet-}$, at linear ranges of 3.28×10^{-5} to $3.28 \times 10^{-4} \text{ M}$ with sensitivities of $186 \text{ nA } \mu\text{M}^{-1}\text{cm}^{-2}$ and $124 \text{ nA } \mu\text{M}^{-1}\text{cm}^{-2}$ at 0.5 V and -0.1 V, separately. The apparent Michaelis-Menten constant (K_m) was estimated to be 0.51 mM and 0.48 mM at 0.5 V and -0.1 V, respectively, which indicated a clearly stronger interaction of hemin with $O_2^{\bullet-}$. The results indicated that the biosensor have strong potential for analysis of biological molecules.

Keywords: Superoxide anion, Electrochemical reduced graphene oxide, Au nanoparticles, Nanohybrid, Biosensor

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